IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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Applicant : Yuichi Kagami

Title : IMAGE PROCESSING, IMAGE READING APPARATUS AND IMAGE PROCESSING METHOD

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Group Art Unit :

Examiner :

Hon. Director of Patents and Trademarks
Washington, D. C. 20231

March 14, 2002

PRELIMINARY AMENDMENT

Sir:

Preliminary to examination, please amend the application, as follows:

Delete paragraph [0005], and add, as follows:

[0005] Data of digitized R, G, and B is corrected respectively in a shading correction component 302, a gamma correction component 303, and a line space correction component 304, and is temporarily stored in a register 305, then it is input into a matrix operation circuit of a color correction component 306. In the shading correction component 302, shading correction processing, which corrects non-uniformity of the light intensity of the light source and irregularity of the sensitivity of the CCD image elements, is applied. In the gamma correction component 303, gamma correction processing, which corrects resolution of the respective R, G, and B

data such that the output data resolution matches the resolution of the input data, is applied. In the line space correction component 304, line space correction processing, which adjusts shifting of the CCD read positions for R, G, and B, is applied.

Delete paragraph [0050], and add, as follows:

[0050] The image processing method, as explained using the flow chart in FIG. 5, comprises an image data generation step (Step S2), a correction value storing step (Steps 3 and 4), a correction operation step (Steps S5 and S6), and a data output step (Step S7). In the image data generation step (Step S2), the image data according to the three color constituents R, G, and B is stored in the register 305 as the input image data. In the correction value storing step (Steps S3 and S4), a color correction matrix A (for example, A1) is stored into the register 502 (the second correction value storing means) from the lookup table 403(a) (the first storing means) where the correction values data (color correction matrices A) for correcting the input image data for each color constituent is stored in advance, in an order based on the data from the PC 8 that specifies the output order of the color constituents R, G, and B. In the correction operation step (Steps S5, S6), the input image data read from the register 305 is operated based on the matrix A1 read from the register 502 for each color constituent. In the data output step (Step S7), the image data R', G', and B' after correction obtained from the correction operation step are output.

Delete paragraph [0070], and add, as follows:

[0070] Next, in the color correction component 306, using the combined matrix C output from the register 502 and the image data R, G, and B output from the register 305, the matrix operation shown below is performed. The color corrected image data R', B' and G' is temporarily stored in the register 309 (output image data storing means), and then it is output in this order to the output device 2 via the PC 8.

Combined Matrix C

$$\begin{pmatrix} R' \\ G' \\ B' \end{pmatrix} = \begin{pmatrix} K_{11} & K_{12} & K_{13} \\ K_{31} & K_{32} & K_{33} \\ K_{21} & K_{22} & K_{23} \end{pmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

IN THE ABSTRACT

Delete lines 1 and 2, IMAGE PROCESSING APPARATUS, IMAGE READING APPARATUS, AND IMAGE PROCESSING METHOD.

REMARKS

The preliminary amendment in the application has been submitted to amend clerical error in the application. Amendment is indicated in the attached copy thereof. The clean version of Abstract is attached.

Respectfully submitted,
KANESAKA AND TAKEUCHI

by _____
Manabu Kanesaka
Reg. No. 31,467
Agent for Applicants

1423 Powhatan Street
Alexandria, VA 22314
(703) 519-9785

Abstract of the Disclosure

An image processing apparatus and an image processing method are developed to process image data and output the data to an output device such as a display like CRT, a printer device, and the likes. An image reading apparatus using this image processing apparatus is also developed. The image processing apparatus stores the image data according to color constituent, sets an order of correction value data to correct input image data for each color constituent according to a command that specifies an output order of the color constituents, performs color correction in a color correction operation circuit using the specified correction value data, and output the image data. Without an output order change circuit, it is possible to perform the color correction and output image data of the color constituents according to an output device, resulting in a compact apparatus.

source 104 irradiates a document 100, and the reflected light is separated into the three primary colors (constituents) of R, G, and B by passing through respective filters of R (red), G (green), and B (blue). They are incident to a photoelectric conversion element CCD 101, for example such as a CCD. The light (analog data) of each color constituent incident to the CCD 101 is input respectively into an A/D converter (analog to digital converter) 102 and digitized.

[0005] Data of digitized R, G, and B is corrected respectively in a shading correction component 302, a gamma correction component 303, and a line space correction component 304, and is temporarily stored in a register 305, then it is input into a matrix operation circuit of a color correction component 306. In the shading correction component 302, shading correction processing, which corrects non-uniformity of the light intensity of the light source and irregularity of the sensitivity of the CCD image elements, is applied.

In the gamma correction component 303, gamma correction processing, which corrects resolution of the respective R, G, and B data such that the output data resolution matches the resolution of the input data, is applied. In the line space correction component ~~305~~ 304, line space correction processing, which adjusts shifting of the CCD read positions for R, G, and B, is applied.

[0006] Also, in the matrix operation circuit 306 of the color correction component, color correction processing such as a matrix operation shown below is performed using correction values for each color.

Color Correction Matrix A

$$\begin{pmatrix} R' \\ G' \\ B' \end{pmatrix} = \begin{bmatrix} K_{11} & K_{12} & K_{13} \\ K_{21} & K_{22} & K_{23} \\ K_{31} & K_{32} & K_{33} \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

[0007] An original image and an output image have different characteristics in color, density, and the like, because of errors in filters that separate the colors into the three primary colors, spectral sensitivity characteristics of the CCD, and image generation

component 306 (Step S13). Then, the matrix operation is performed (Step S14).

$$\begin{pmatrix} R' \\ G' \\ B' \end{pmatrix} = \begin{bmatrix} N_{11} & N_{12} & N_{13} \\ N_{21} & N_{22} & N_{23} \\ N_{31} & N_{32} & N_{33} \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

Y1

[0048] After being output to the register 309, and temporarily stored in the register 309, any one of R', G', and B' is output as monotone image data to the output device 2 via the PC 8 (Step S15).

[0049] Next, the image processing method applied to the image reading apparatus 1 is explained.

[0050] The image processing method, as explained using the flow chart in FIG. 5, comprises an image data generation step (Step S2), a correction value storing step (Steps 3 and 4), a correction operation step (Steps S5 and S6), and a data output step (Step S7). In the image data generation step (Step S2), the image data according to the three color constituents R, G, and B is stored in the register 305 as the input image data. In the correction value storing step (Steps S3 and S4), a color correction matrix A (for example, A1) is stored into the register 502 (the second correction value storing means) from the lookup table 403(a) (the first storing means) where the correction values data (color correction matrices A) for correcting the input image data for each color constituent is stored in advance, in an order based on the data from the PC 8 that specifies the output order of the color constituents R, G, and B. In the correction operation step (Steps S5, S6), the input image data read from the register 305 is operated based on the matrix A1 read from the register 502 for each color constituent. In the data output step (Step S7), the image data R', G', and B' after correction obtained from the correction operation step are output.

[0051] As explained above, according to the present invention, in the case of the color mode, by selecting a color correction matrix according to the image characteristics of the output device, and

specifying the color correction matrix corresponding to the image characteristics of the output device 2, and the output order data indicating the output order of R, G, and B, from the PC 8. One color correction matrix A (for example, A1) corresponding to the output device 2 is selected from the color correction lookup table 403(a) according to these data and the address assigning component 503. One output order changing matrix V (for example, V2) is selected according to the output order data from the output order lookup table 403(b), and they are output to the operation component 501.

[0069] In the operation component 501, the matrix operation shown below is performed. Through this operation, the color correction matrix A1 is subjected to row exchange (resorting of the data order). Also, a combined matrix C for determining the mixture ratio of each color constituent in color correction processing and for changing the output order is obtained. The results are output to the register 502.

Combined Matrix C V2 A1

$$\begin{pmatrix} K_{11} & K_{12} & K_{13} \\ K_{31} & K_{32} & K_{33} \\ K_{21} & K_{22} & K_{23} \end{pmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} K_{11} & K_{12} & K_{13} \\ K_{21} & K_{22} & K_{23} \\ K_{31} & K_{32} & K_{33} \end{bmatrix}$$

[0070] Next, in the color correction component 306, using the combined matrix C output from the register 502 and the image data R, G, and B output from the register 305, the matrix operation shown below is performed. The color corrected image data R', B' and G' is temporarily stored in the register 309 (output image data storing means), and then it is output in this order to the output device 2 via the PC 8.

Combined Matrix C

$$\begin{pmatrix} R' \\ G' \\ B' \end{pmatrix} = \begin{pmatrix} K_{11} & K_{12} & K_{13} \\ K_{21} & K_{22} & K_{23} \\ K_{31} & K_{32} & K_{33} \end{pmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

[0071] Next, the monotone mode is explained.

[0072] In the case of the monotone mode, the CPU 5 receives the

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An image processing apparatus and an image processing method are developed to process image data and output the data to an output device such as a display like CRT, a printer device, and the likes. An image reading apparatus using this image processing apparatus is also developed. The image processing apparatus stores the image data according to color constituent, sets an order of correction value data to correct input image data for each color constituent according to a command that specifies an output order of the color constituents, performs color correction in a color correction operation circuit using the specified correction value data, and output the image data. Without an output order change circuit, it is possible to perform the color correction and output image data of the color constituents according to an output device, resulting in a compact apparatus.